

**EXHAUST VIBRATION DECOUPLING CONNECTOR
WITH LOCKED LINER TUBES**

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation-in-part of application number 10/307,124, filed

5 11/26/2002.

BACKGROUND OF THE INVENTION

This invention relates to engine-exhaust connectors that employ bellows or bellows-functional apparatuses in combination with mesh-wire washers, gaskets, or other resilient and high-temperature absorbency spacers for decoupling that prevents 10 transfer of exhaust vibration and noise to mufflers, smog-control and other exhaust-downstream devices.

Numerous bellows apparatuses are known for joining flexible conveyances. Many patents and other prior art could be cited.

For specificity of this invention, however, only one, U.S. Patent Number 15 6,086,110, granted to Lee, *et al.* on July 11, 2000 will be referenced in detail. There is no other prior art known to be sufficiently similar to merit anticipatory comparison. The Lee, *et al.* patent and this invention disclose most nearly the use of a bellows in combination with mesh-wire damping washers to decouple vibration of exhaust of an internal-combustion engine from exhaust-treatment devices and structures that 20 include smog-control devices, mufflers and exhaust pipes. However, the combinations, structures, positional relationships, functional relationships, manufacturing requirements, attachment methods, costs, durability and effectiveness of bellows and mesh-wire washers of this invention and the Lee, *et al.* patent are all different.

Different structure and working relationship of parts of the Lee, *et al.* patent and this invention require different manufacturing and application features that set them apart additionally. The Lee, *et al.* patent requires welding, metal-work bending and tapering interspersed with machining and assembly. It is most suited to integrated 5 production of an entire decoupling system in a single manufacturing facility. Production for the Lee, *et al.* patent is not readily segmental for outsourcing or competitive participation. It requires high-cost production with interspersed production methods and uses of machinery that inhibit competitive interests from encroachment into OEM or after-market business activities. Its high production cost 10 can increase gross sales which increases profit which benefits its producer, but only as long as proprietary protection and business strength can be maintained adequately.

This invention, however, provides low-cost and easily segmented production that can be out-sourced readily. Also, it can be attached and detached quickly, easily and reliably to exhaust manifolds and to downstream exhaust-treatment, muffler and 15 exhaust-pipe components.

Examples of most-closely related known but different devices are described in the following patent documents:

	<u>Patent No.</u>	<u>Inventor</u>	<u>Issue Date</u>
20	US 6,086,110	Lee, <i>et al.</i>	07-11-2000
	US 5,653,478	McGurk, <i>et al.</i>	08-05-1997
	US 5,639,127	Davey	06-17-1997
	US 5,506,376	Godel	04-09-1996
	US 5,482,330	Holzhausen	01-09-1996
	US H1101	Waclawik	09-01-1992
25	US 247,591	White	09-27-1881
	JP 2-129489		1990
	EU 0 681 097 A1		02-06-1995
	DE 33 21 382 A1		02-16-1984

SUMMARY OF THE INVENTION

Objects of patentable novelty and utility taught by this invention are to provide an exhaust-vibration decoupling connector which:

- 5 is flexible centrally and over a long area to increase use life;
- is highly effective in isolating or decoupling exhaust vibration and noise from exhaust-related engine components;
- has a locked liner tube to prevent failure caused by linear over extension;
- 10 can be manufactured at low cost;
- has segmental production features that can be outsourced for competitive production;
- can be assembled and attached to an exhaust system quickly and easily;
- can have long use life; and
- 15 can be detached for maintenance and replacement quickly and easily.

This invention accomplishes these and other objectives with an exhaust-vibration decoupling connector having an inlet tube extended downstream from a decoupler inlet to a damper step. The damper step includes a radially inward extension of the inlet tube to a damper seat that includes further downstream extension of the inlet tube for seating a vibration damper. An outlet tube is extended upstream from a decoupler outlet to a damper restraint that includes a radially inward extension of the outlet tube to proximate an outside surface of the damper step. A vibration damper is positioned on the damper seat intermediate the damper step and the damper restraint at proximate midway between the decoupler inlet and the decoupler outlet. A decoupler bellows includes a bellows upstream connector

proximate an outside periphery of the inlet tube and a bellows downstream connector proximate an outside periphery of the outlet tube. The decoupler bellows has a plurality of convolutions intermediate the bellows upstream connector and the bellows downstream connector. Enclosing an outside periphery of the decoupler

5 bellows can be a resilient sleeve that is extended from proximate the bellows upstream connector to proximate the bellows downstream connector. External to the resilient sleeve if used and external to the decoupler bellows is a cover sleeve that is extended from proximate the bellows downstream connector to a predetermined distance from the bellows upstream connector for rigid protection of the decoupler

10 bellows and the resilient sleeve if used. The decoupler inlet is articulated for attachment to an exhaust-outlet structure on an engine. The decoupler outlet is articulated for attachment to an exhaust-treatment structure. The inlet tube may have a bend at an upstream end where it interconnects with a bend on a downstream end of the outlet tube to limit bellows extension due to linearly expansive forces that

15 could cause failure of the connector.

The above and other objects, features and advantages of the present invention should become even more readily apparent to those skilled in the art upon a reading of the following detailed description in conjunction with the drawings wherein there is shown and described illustrative embodiments of the invention.

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BRIEF DESCRIPTION OF DRAWINGS

This invention is described by appended claims in relation to description of a preferred embodiment with reference to the following drawings which are explained briefly as follows:

25 **FIG. 1** is a partially cutaway side view of the invention having a flex cover and a cover shield external to a bellows that has flexibly parallel walls and has a vibration

damper that is a mesh-wire washer in a damper fixture midway between a decoupler inlet and a decoupler outlet;

FIG. 2 is a partially cutaway side view of the invention having the flex cover and the cover shield external to the a vibration damper that includes wave springs between wave-spring washers;

FIG. 3 is a partially cutaway side view of the invention without the cover shield external to the bellows and includes the vibration damper that is the mesh-wire washer in the damper fixture;

FIG. 4 is a partially cutaway side view of the invention without the flex cover and the cover shield external to the bellows and with a vibration damper that includes a helical spring; [[and]]

FIG. 5 is a partially cutaway side view of the invention with the flex cover and the cover shield external to the bellows that has vibration-damping material that can be mesh-wire washers in the undulations of the bellows and includes a vibration damper that is a spring-side damper in the damper fixture[[.]];

FIG. 6 is the FIG. 1 view of the invention with a ninety degree locking bend on the inlet tube which interlocks with the outlet tube to provide a liner locked against linearly expansive forces; and

FIG. 7 is the FIG. 1 view of the invention with a slanted locking bend on the inlet tube which interlocks with the outlet tube to provide a liner locked against linearly expansive forces.

DESCRIPTION OF PREFERRED EMBODIMENT

Listed numerically below with reference to the drawings are terms used to describe features of this invention. These terms and numbers assigned to them designate the same features throughout this description.

5	1. Inlet tube 2. Decoupler inlet 3. Damper fixture 4. Outlet tube 5. Decoupler outlet 10 6. Mesh-wire washer 7. Bellows 8. Parallel walls 9. Upstream bellows attachment 10. Downstream bellows attachment 15 11. Bellows inside perimeter 12. Undulations 13. Flex cover 14. Upstream flex attachment 15. Downstream flex attachment 20 16. Shield sleeve 17. Shield attachment 18. First undulation wall 19. Second undulation wall 20. First flex-cover wall 21. Second flex-cover wall 22. Inlet-tube step 23. Damper seat 24. <u>Outlet-tube step/inward bend</u> 25. Wave-spring damper 26. Wave-spring washers 27. Helical-spring damper 28. Spring-side damper 29. Helical spring 30. First wall 31. Second wall 32. Braid cap 33. Exhaust-outlet structure 34. Exhaust-treatment structure 35. Mesh-wire ring 36. <u>90° inlet tube locking bend</u> 37. <u>Slanted inlet tube locking bend</u>
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Referring to FIG. 1, an inlet tube 1 is extended downstream from a decoupler 25 inlet 2 to proximate an upstream portion of a damper fixture 3. An outlet tube 4 is extended upstream from a decoupler outlet 5 to proximate a downstream portion of the damper fixture 3. The damper fixture 3 is proximate midway between the decoupler inlet 2 and the decoupler outlet 5.

A vibration damper, which in this embodiment is a mesh-wire washer 6, is 30 positioned removably in the damper fixture 3. A bellows 7, with preferably parallel walls 8, has an upstream bellows attachment 9 proximate the decoupler inlet 2. The bellows 7 has a downstream bellows attachment 10 proximate the decoupler outlet

5. The bellows 7 has a bellows inside perimeter 11 that is radially outward predeterminedly from a radially outside perimeter of the mesh-wire washer 6 or other vibration damper. The bellows inside perimeter 11 is defined by inside peripheries of undulations 12 of the bellows 7.

5 A flex cover 13 has an upstream flex attachment 14 proximate the decoupler inlet 2. The flex cover 13 has a downstream flex attachment 15 proximate the decoupler outlet 5. The bellows inside perimeter 11 is radially outward predeterminedly from a radially outside perimeter of the wire-mesh washer 6 or other vibration damper.

10 A shield sleeve 16 has a shield attachment 17 proximate the decoupler outlet 5. The shield sleeve 16 has a shield inside perimeter that is positioned radially outward predeterminedly from a radially outside perimeter of the flex cover 13.

15 The upstream bellows attachment 9 includes an upstream bellows sleeve extending downstream axially a predetermined attachment distance from proximate the decoupler inlet 2 to a first undulation wall 18 that is extended radially intermediate the upstream bellows sleeve and a first side of a first of the undulations 12 of the bellows 7.

20 The downstream bellows attachment 10 includes a downstream bellows sleeve extending upstream axially a predetermined attachment distance from proximate the decoupler outlet 5 to a second undulation wall 19 that is extended radially intermediate the downstream bellows sleeve and a second side of a last of the undulations 12 of the bellows 7.

25 The upstream bellows sleeve, shown at the upstream bellows attachment 9, includes an inside periphery that is positioned on an outside periphery of a fastener portion of the inlet tube 1. The downstream bellows sleeve, shown at the downstream

bellows attachment 10, includes an inside periphery that is positioned removably on an outside periphery of a fastener portion of the outlet tube 4.

The upstream flex attachment 14 includes an upstream flex-cover sleeve extending downstream axially a predetermined attachment distance from proximate

5 the decoupler inlet 2 to a first flex-cover wall 20 that is extended radially intermediate the upstream flex-cover sleeve and a first attachment side of the flex cover 13. The downstream flex attachment 15 includes a downstream flex-cover sleeve extending upstream axially a predetermined attachment distance from proximate the decoupler outlet 5 to a second flex-cover wall 21 that is extended radially intermediate the 10 downstream flex-cover sleeve and a second attachment side of the flex cover 13.

The upstream flex-cover sleeve includes an inside periphery that is positioned removably on an outside periphery of the upstream bellows sleeve. The downstream flex-cover sleeve includes an inside periphery that is positioned removably on an outside periphery of the downstream bellows sleeve.

15 The inlet tube 1 is circumferential with an inside perimeter and an outside perimeter. The outlet tube 4 is circumferential with an inside periphery and an outside periphery. The inside periphery and the outside periphery of the inlet tube 1 are predeterminedly smaller than the inside periphery and the outside periphery of the outlet tube 4. The damper fixture 3 can include an inlet-tube step 22 extended 20 radially inward to a damper seat 23 having an axial downstream extension of the inlet tube 1. The damper fixture 3 can include an outlet-tube step 24 extended radially inward to predeterminedly proximate an outside periphery of the damper seat 23. The inlet-tube step 22 includes a first side of the damper fixture 3 and the outlet-tube step 24 includes a second side of the damper fixture 3.

25 The outlet-tube step 24 can be articulated to allow axial and pivotal travel of the outlet tube 4 in relation to the inlet tube 1 predeterminedly. To illustrate this

pivotal feature, the outlet-tube step 24 in **FIG. 5** is depicted to be arcuate proximate the damper seat 23.

For the embodiments of this invention shown in **FIGS. 1 and 3**, the vibration damper includes the mesh-wire washer 6 having an inside periphery that is positioned 5 removably on the damper seat 23, an outside periphery that is predeterminedly smaller than the bellows inside perimeter 11, a first side proximate the inlet-tube step 22, and a second side proximate the outlet-tube step 24.

For the embodiment shown in **FIG. 2**, the vibration damper includes one or 10 more wave springs 25 that can include wave-spring washers 26 that are in detachably sealed contact with the inlet-tube step 22 and the outlet-tube step 24.

For the embodiments shown in **FIG. 4**, the vibration damper includes a helical-spring damper 27.

For the embodiment shown in **FIG. 5**, the vibration damper includes a spring-side damper 28 having a helical spring 29 in a circumferential channel with a first 15 wall 30 adjacent to the inlet-tube step 22 and a second wall 31 adjacent to the outlet-tube step 24. The circumferential channel is arcuate intermediate the first wall 30 and the second wall 31. The first wall 30 and the second wall 31 have inside peripheries proximate the outside periphery of the damper seat 23.

For the embodiments shown in **FIGS. 1- 5**, the flex cover 13 includes a heat-20 resistant and flexible material that is reinforced with wire network predeterminedly. The flex cover 13 can include a braided-wire material. The flex cover 13 can include a braid cap 32 that is positioned intermediate the upstream flex attachment 14 and predetermined exhaust-outlet structure 33 to which the exhaust-vibration decoupling connector is attachable.

As shown in FIGS. 1-5, the upstream bellows attachment 9 is articulated for sealed attachment to the predetermined exhaust-outlet structure 33. The downstream bellows attachment 10 is articulated for sealed attachment to a predetermined exhaust-treatment structure 34 that is fluidly downstream from the exhaust-outlet structure. 5

The upstream bellows attachment 9 is disposed a snug-fit distance from the downstream bellows attachment 10 for fitting snugly intermediate the exhaust-outlet structure 33 and the exhaust-treatment structure 34 predeterminedly.

The exhaust-outlet structure 33 normally includes an exhaust flange of sorts. 10 The exhaust-treatment structure 34 normally includes a conveyance tube or pipe from a smog-control device, a muffler or an exhaust pipe. The exhaust-outlet structure 33 also can include downstream connections for a smog-control device or muffler. These structures are shown figuratively without specificity of attachment structures for particular engines or exhaust-treatment devices.

15 For the embodiments shown in FIGS. 1-2 and 5, the shield sleeve 16 has a shield length that is less than the snug-fit distance for allowing axial distance change between the decoupler inlet 2 and the decoupler outlet 5 and for allowing pivotal movement of the decoupler outlet 5 predeterminedly.

For the embodiments shown in FIGS. 1-5, the bellows 7 includes flexibly 20 parallel walls 8 intermediate arcuately flexible floors and roofs.

Referring to FIG. 5, the bellows 7 can include damping filler intermediate internal walls which include the parallel walls 8 of undulations 12. The damping filler can include mesh-wire rings 35.

FIGS. 6 and 7 show embodiments of the invention in which the inlet tube 1
25 has an outward radial bend, such as a ninety degree (90°) bend 36 or slanted bend 37,

respectively, which interlocks with an inward radially bend 24, also called a step, on the outlet tube 4 so as to limit extension of the bellows 7 due to linearly expansive forces that may cause failure of the connector. This locking feature allows the device to experience only compressive movement and prevents the flex cover or braid 13 from handling linearly extensive expansion forces that could cause the device to break apart.

A new and useful exhaust-vibration decoupling connector having been described, all such foreseeable modifications, adaptations, substitutions of equivalents, mathematical possibilities of combinations of parts, pluralities of parts, 10 applications and forms thereof as described by the following claims and not precluded by prior art are included in this invention.